# Systematic Contact Mechanics Investigation of Micro-patterned Triboelectric Nanogenerator

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## Abstract.

Triboelectric nanogenerators (TENGs) are a newly emerging technology to sustainably harvest electrical power from mechanical energy, based on triboelectrification and electrostatic induction during the periodic contact of two tribo-contacting layers [1]. Over the past decade, TENGs have gained a significant amount of research interest from the materials science and electrical engineering communities. Even though a significant amount of research has been done in the field of TENGs, the fundamental contact mechanics of TENGs is not very clear yet.

In this work we present a systematic contact mechanics investigation on a simple, inexpensive, and robust micro-patterned TENG device. This newly developed TENG (Fig. 1) consists of a combination of hard (Tribo-layer 1) and soft materials (Tribo-layer 2). Highly controlled and well-defined topographies (over a wide size range) were numerically created and produced using an additive manufacturing technique (3D printing). Taking advantage of a recently established replica-moulding procedure, the 3D printed surfaces were utilised to develop replicas on a silicon-based viscoelastic polymer [2]. A 3D optical surface profiler was used for the visualization of the manufactured moulds and developed tribo-layers. Surface morphological characterization results confirmed the high accuracy of developed tribo-surfaces. Linear electrodynamic mechanical equipment was indigenously modified to perform highly controlled tribo-electric measurement, based on the vertical contact-separation mode. Due to the flat-on-flat contact configuration of the TENG contacting surfaces, a tiny miss-alignment could drastically alter the contact area and thus modify the triboelectric output. Therefore, a 360° free-control rotation system was incorporated into the test-rig to achieve a near perfect contact. Systematic triboelectric measurements were carried out to investigate the influence of applied normal and the oscillating frequency. The output voltage of the TENG device showed an increasing behaviour with an increase in normal load, for the whole frequency range chosen. Corresponding output voltage and short-circuit current results were correlated with surface-specific topographies and were discussed with regard to the apparent and real contact area, localization of strain, and interfacial adhesive energy. Finally, the original TENG device developed, and the accompanying characterisation could offer important assistance to better design and develop TENGs in future.

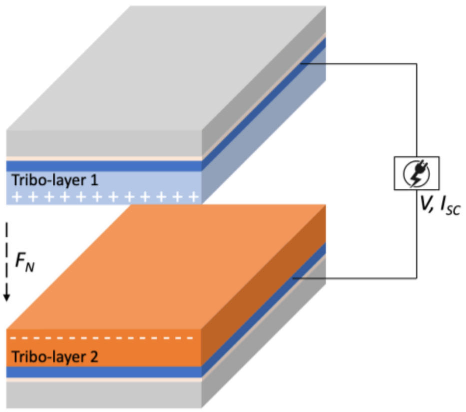


**Figure 1:** Schematic showing the vertical contact-separation mode triboelectric nanogenerator used in this work. $F_N$ = Applied normal load, $V$ = Output voltage, and $I_{SC}$ = Short circuit current.

## References

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